COMPUTATION OF HEMODYNAMIC QUANTITIES FROM ANGIOGRAPHIC DATA

RELATED APPLICATIONS

[0001] This application is a continuation of U.S. application Ser. No. 14/947,954, filed Nov. 20, 2015, which is a continuation of U.S. application Ser. No. 13/937,313, filed Jul. 9, 2013, through which this application claims the benefit of U.S. Provisional Application No. 61/669,325, filed Jul. 9, 2012, and U.S. Provisional Application No. 61/812,346, filed Apr. 16, 2013. The entire contents of the parent application, grandparent application, and both provisional applications are incorporated herein by reference, except that in the event of any inconsistent disclosure or definition from the present specification, the disclosure or definition herein shall be deemed to prevail.

TECHNICAL FIELD

[0002] The present teachings relate generally to the computation of hemodynamic quantities, including but not limited to fractional flow reserve (FFR), which may be used in the assessment of coronary artery disease.

BACKGROUND

[0003] Cardiac disease is the leading cause of death for men and women in the United States and accounts for at least 30% of deaths worldwide. Although recent medical advances have resulted in improvements in the diagnosis and treatment of complex cardiac diseases, the incidence of premature morbidity and mortality remains large, at least in part due to a dearth of accurate in vivo and in vitro estimates of patient-specific parameters indicative of a patient's anatomy, physiology, and hemodynamics.

[0004] Medical imaging based techniques (e.g., computed tomography, angiography, and the like) may be used in clinical practice for characterizing the severity of stenosis in the coronary arteries. However, the anatomical assessment provided by such techniques is oftentimes inadequate in clinical decision-making. For example, anatomical assessment of the severity of coronary artery stenosis may lead to overestimation or underestimation, neither of which is desirable. On the one hand, overestimation of stenosis severity may lead to unnecessary intervention and subsequent risk of restenosis. On the other hand, underestimation may lead to non-treatment. An accurate functional assessment of a patient's risk of cardiovascular disease may require measurements of pressure and/or flow, which are determined invasively.

[0005] One type of invasive measurement used in the determination of FFR values involves the insertion of a pressure wire into a patient's artery. One drawback of using a pressure wire is the possibility of disrupting plaque and triggering a cardiac event in the patient. Another potential problem in using a pressure wire is the risk of perforating the lumen of a blood vessel with the wire. Moreover, the use of a pressure wire is time consuming and may limit a medical practitioner's ability to collect data in real time and apply the data in a clinical setting (e.g., while a patient is in the midst of a procedure). In addition, the use of a pressure wire is simply not feasible with certain patients due to their constitutions and/or severities of disease state.

SUMMARY

[0006] The scope of the present invention is defined solely by the appended claims, and is not affected to any degree by the statements within this summary.

[0007] Angiography-based methods and systems for computing hemodynamic quantities in accordance with the present teachings involve calculating flow rates and/or changes in pressure in a patient's blood vessel. The hemodynamic quantity—for example, FFR—may be computed based on the calculated flow rates and/or changes in pressure.

[0008] By way of introduction, a computer-implemented method for computing a hemodynamic quantity in accordance with the present teachings includes: (a) acquiring angiography data from a patient; (b) calculating, by a processor, a flow and/or a change in pressure in a blood vessel of the patient based on the angiography data; and (c) computing, by the processor, the hemodynamic quantity based on the flow and/or the change in pressure.

[0009] A computer-implemented method for computing a fractional flow reserve in accordance with the present teachings includes: (a) acquiring angiography data from a patient, wherein the acquiring includes monitoring movement of a contrast agent through a blood vessel of the patient; (b) calculating, by a processor, a flow based on the angiography data; (c) calculating, by the processor, a change in pressure in the blood vessel of the patient, wherein the blood vessel comprises a stenosis; and (d) computing, by the processor, the fractional flow reserve based on the flow and the change in pressure.

[0010] A system for computing a hemodynamic quantity in accordance with the present teachings includes: (a) a processor; (b) a non-transitory memory coupled to the processor; (c) first logic stored in the memory and executable by the processor to cause the processor to acquire angiography data from a patient; (d) second logic stored in the memory and executable by the processor to cause the processor to calculate a flow based on the angiography data; (e) third logic stored in the memory and executable by the processor to cause the processor to calculate a change in pressure in a blood vessel of the patient based on the angiography data; and (f) fourth logic stored in the memory and executable by the processor to cause the processor to compute the hemodynamic quantity based on the flow and/or the change in pressure.

[0011] A non-transitory computer readable storage medium in accordance with the present teachings has stored therein data representing instructions executable by a programmed processor for computing a hemodynamic quantity. The storage medium includes instructions for: (a) acquiring angiography data from a patient; (b) calculating a flow based on the angiography data; (c) calculating a change in pressure in a blood vessel of the patient based on the angiography data; and (d) computing the hemodynamic quantity based on the flow and/or the change in pressure.

BRIEF DESCRIPTION OF THE DRAWINGS

[0012] FIG. **1** shows an exemplary flow chart of a representative method for computing hemodynamic quantities.

[0013] FIG. **2** shows a block diagram of an exemplary implementation of a system for computing hemodynamic quantities.